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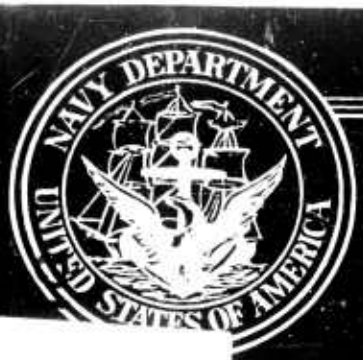

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AIRBORNE RADIO DIVISION - ENGINEERING ANALYSIS SECTION

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(9) INTERIM REPORT ON
TYPE TEST OF
(6) AN/ASG-10.

By I. W. Fuller and M. L. Burnett

(10) - Report R-2609 -

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ABSTRACT

1. The AN/ASG-10 is a "Toss-Bombing" director. Its purpose is to enable aircraft to execute glide bombing attacks from increased altitudes (approximately 1700 to 11,000 feet) with a high degree of accuracy. "Toss-Bombing" by this method permits the pilot to fly a natural course at his objective at a relatively high altitude. Then, while he dives in a collision course at his objective (at any angle between 15° and 60°) the equipment computes at which time the bomb is to be released after he pulls out of the dive. Since the bomb is released after the pilot pulls out of the dive, the bomb, in effect, is thrown ahead of the original dive line by the amount determined by the equipment as being necessary to overcome the effect of gravity. The AN/ASG-10 automatically releases the bombs when the correct time after pull-out is reached.

2. The results of the type tests show that the equipment will work satisfactorily over a temperature range of minus 30°C to plus 50°C at low humidities. If the equipment is to be operated under humid conditions, the wire used in all the units and all cables should be vinylite covered wire. It is also desirable to treat the MPI potentiometer and the test switch so that humidity will not give low leakage resistance.

3. Vibration tests have shown that the shock mounts used on this equipment are unsatisfactory. However, since the vibration tests have not been completely finished, the full results will be reported in the final report on this problem.

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RESULTS OF TESTS

4. Throughout all tests mentioned in this report, an experimental Bureau of Standards test clock was used since at the time the tests were started, a TS-362 was not available. The time values are thought to be more accurate than the TS-362 since a 60 cycle power source was used for all tests whereas the TS-362 has a vibrator for a frequency source on its clock.

5. The results of the tests, are taken up in the order in which they were conducted except for the vibration tests which were partially done before the Spray Test and are to be finished afterward. The results of the Vibration Test will be reported in the final report.

Temperature Tests

6. The AN/ASG-10 equipment was set up and operated at room temperatures. A series of readings were taken to determine "Time Out" values for various settings of the "M.P.I." and "Stick Offset" controls. The "Time Out" values obtained during an eight (8) hour period of continuous operation at 23°C are shown below:

TIME OUT VALUES AT 23°C

TIME ON	TIME OUT SECOND 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
1 minute	4.96	9.97	14.98	0	0
"	5.81	11.86	---	+5	0
"	4.35	8.70	---	-5	0
"	3.11	8.11	---	0	10
"	1.34	6.36	---	0	Torp
30 minutes	4.95	9.95	14.93	0	0
"	5.81	11.66	---	+5	0
"	4.32	8.67	---	-5	0
"	3.10	8.09	---	0	10
"	1.34	6.33	---	0	Torp
4 Hours	4.97	9.93	14.90	0	0
"	5.83	11.68	---	+5	0
"	4.33	9.67	---	-5	0
"	3.10	8.07	---	0	10
"	1.33	6.31	---	0	Torp
8 Hours	4.97	9.96	14.91	0	0
"	5.83	11.64	---	+5	0
"	4.34	8.67	---	-5	0
"	3.09	8.06	---	0	10
"	1.33	6.31	---	0	Torp

7. The equipment was then placed in a temperature controlled box and the temperature was lowered to minus 30°C. The equipment was allowed to stabilize at this temperature and "Time Out" values were then measured as follows:

TIME OUT VALUES AT MINUS 30°C

TIME ON	TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
1 minute	4.95	9.92	14.93	0	0
"	5.86	11.73	---	+5	0
"	4.29	8.61	---	-5	0
"	3.07	8.03	---	0	10
"	1.18	6.14	---	0	Torp
30 minutes	4.93	9.89	14.84	0	0
"	5.82	11.67	---	+5	0
"	4.29	8.59	---	-5	0
"	3.05	7.99	---	0	10
"	1.15	6.08	---	0	Torp

The temperature was then raised to minus 10°C, and the same measurements repeated. This data is similarly shown below:

TIME OUT VALUES AT MINUS 10°C

TIME ON	TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
1 minute	4.94	9.89	14.87	0	0
"	5.82	11.67	---	+5	0
"	4.31	8.63	---	-5	0
"	3.06	8.02	---	0	10
"	1.20	6.17	---	0	Torp
30 minutes	4.94	9.91	14.87	0	0
"	5.82	11.67	---	+5	0
"	4.31	8.63	---	-5	0
"	3.07	8.04	---	0	10
"	1.21	6.19	---	0	Torp

The measurements of "Time Out" values at 10°C compare favorably with those taken at lower temperatures. Values measured at 10°C are given below:

TIME OUT VALUES AT 10°C

TIME ON	TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
1 minute	4.95	9.94	14.91	0	0
"	5.84	11.69	---	+5	0
"	4.32	8.65	---	-5	0
"	3.07	8.04	---	0	10
"	1.25	6.24	---	0	Torp
30 minutes	4.95	9.93	14.91	0	0
"	5.82	11.68	---	+5	0
"	4.32	8.65	---	-5	0
"	3.10	8.08	---	0	10
"	1.28	6.26	---	0	Torp

Measurements of "Time Out" values made at 30°C are tabulated below:

TIME OUT VALUES AT 30°C

TIME ON	TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
1 minute	4.96	9.97	14.97	0	0
"	5.85	11.72	---	+5	0
"	4.33	8.68	---	-5	0
"	3.09	8.10	---	0	10
"	1.29	6.30	---	0	Torp
30 minutes	4.97	9.96	14.95	0	0
"	5.84	11.70	---	+5	0
"	4.33	8.66	---	-5	0
"	3.10	8.09	---	0	10
"	1.31	6.30	---	0	Torp

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The relative humidity during all of the above measurements was purposely maintained low. At 50°C the relative humidity was 65% for the "Time Out" values listed below:

TIME OUT VALUES AT 50°C, 65% R. H.

TIME ON	TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M. P. I. SETTING	STICK OFFSET SETTING
1 minute	4.95	9.91	14.85	0	0
"	5.84	11.67	---	+5	0
"	4.32	8.63	---	-5	0
"	3.06	8.02	---	0	10
"	1.30	6.25	---	0	Torp
30 minutes	4.94	9.87	---	0	0
	5.82	11.59	14.73	+5	0
	4.31	8.59	---	-5	0
	3.06	7.97	---	0	10
	1.28	6.19	---	0	Torp

Frost Test

8. The temperature was then lowered to minus 30° C. After several hours at this temperature, the door to the chamber was opened, allowing warm air to come in and form frost on the equipment. This frost was allowed to melt. The equipment was then turned on and time out values were checked. The equipment worked satisfactorily for a few minutes. It was found that after these few minutes of operation "time" could not be fed into the equipment. The altimeter was disconnected. After this it was possible to feed "time" into the equipment and normal "Time Out" values were observed as follows:

TIME OUT VALUES

(With melted frost on the equipment at room temperature and with the altimeter disconnected.)

TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
4.97	9.95	14.92	0	0
5.85	11.72	---	+5	0
4.33	8.66	---	-5	0
3.09	8.07	---	0	10
1.26	6.26	---	0	Torp

9. After the altimeter was disconnected from the equipment, a megohm-meter was used to measure the impedance to ground from the pins of the plug receptacle on the back of the altimeter. The impedance to ground was found to be less than 300,000 ohms. This leakage resistance was caused by the presence of moisture on the contacts inside the altimeter face. When the altimeter is dry, the resistance to ground of these same pins should be of the order of 100 megohms or higher.

10. Upon further investigation it was found that an impedance of 4 megohms or less to ground in the altimeter circuit would render the equipment inoperative.

Altitude Test

11. The AN/ASG-10 was set up in the altitude chamber and a pre-altitude check made of the calibration. The altitude chamber temperature was then lowered to minus 40°C and stabilized. Some of the cables were rather stiff but no method was available for determining the effects of vibration at this temperature. The cage and uncage motor was checked for proper caging and worked satisfactorily. The altitude chamber was then evacuated to 20,000 feet and then slowly lowered to sea level to check contacts on the altimeter. All contacts were satisfactory. The chamber was then evacuated to 37,000 feet and "Time Out" values recorded at altitudes down to sea level. No checks were made of the altimeter accuracy or lag. No particular changes in "Time Out" values were found to be caused by altitude. The "Time Out" values can be found listed below:

"TIME OUT" VALUES UNDER ALTITUDE (-40°C)

	MPI = 0		SO = 0
ALTITUDE	1 Sec IN	2 Sec IN	3 Sec IN
0	4.94	9.89	14.84
20,000 ft.	4.95	9.89	14.85
34,000 ft.	4.94	9.89	14.84
37,000 ft.	4.94	9.88	14.82

Humidity Test

12. The AN/ASG-10 was set up in the temperature chamber and the calibration checked, then, it was subjected to conditions of 50°C and 97% humidity for 48 hours. It was then turned on and after 10 minutes warm-up, "Time Out" values were recorded. The "Time Out" values before and after the humidity are recorded on the following page:

TIME OUT VALUES

	TIME OUT SEC 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
Before Humidity	4.94	9.87	14.73	0	0
" "	5.82	11.59		+5	0
" "	4.31	8.59		-5	0
" "	3.06	7.97		0	10
" "	1.28	6.19		0	Torp
After "	3.80	7.33	10.45	0	0
" "	5.84	11.67		+5	0
" "	2.82	5.30		-5	0
" "	1.82	5.24		0	10
" "	.85	4.28		0	Torp

13. Checks were made to determine the reason for the low "Time Out" values encountered during the humidity test. It was found that the wire used throughout the control box, the computer, and the gyro was giving quite a bit of leakage trouble. The resistance to ground of these wires was somewhere around 300,000 ohms. Since nothing but erratic results could be expected with this much leakage, the control box was completely rewired with vinylite wire and the leads in the computer, which connect to high impedance circuits, were changed to vinylite.

14. After these changes were made, another 48 hour humidity test was run. Readings were taken of "Time Out" values. After the set had been working for 30 minutes, it stopped completely and it was impossible to put in "time". This was found to be caused by leakage across the "Test" switch on the control box. The leakage was great enough to prevent V102 from firing. The test switch was then disconnected and the set worked satisfactorily. The "Time Out" values after this second 48 hour test are shown below.

TIME OUT VALUES

("Test" Switch disconnected)

2nd Humidity Test 1 Sec IN	2 Sec IN	3 Sec IN	M.P.I. SETTING	STICK OFFSET SETTING
4.82	9.63	14.34	0	0
5.82	11.65		+5	0
4.15	8.26		-5	0
2.94	7.76		0	10
2.05	6.87		0	Torp

15. After the second humidity test all wires in the computor, excluding the ones inside the sealed chamber and the 24 V leads, were changed to vinylite wire; then, a third 48 hour test run. The results of this test gave:

TIME OUT VALUES

3rd Humidity Test TIME OUT SEC			M.P.I.	("Test" Switch disconnected) STICK OFFSET
1 Sec In	2 Sec In	3 Sec In	SETTING	SETTING
4.72	9.39	13.94	0	0
5.80	11.59		+5	0
4.00	7.93		-5	0
2.81	7.47		0	10
1.94	6.53		0	Torp

16. During these tests the cables were checked and the resistance to ground measured around 100 megohms. It was found that some of the error in the "Time Out" values due to humidity was caused by leakage across the terminals and possibly inside of potentiometer R301 which is the MPI control. Leakage across R103 and across the terminal board it is mounted on was also a source of error. Some error was encountered due to leakage across the terminals on the base of the sealed chamber. The reason for the erratic readings obtained in the Torpedo position was found to be due to R302 changing value during the test. At the end of these tests, R302 was replaced.

17. Intermittently, after the first 48 hours of humidity, the release relay would fail to make good contact and consequently no release occur. If subjected to humid conditions, this relay must be cleaned frequently to make sure of positive contact.

Spray Test

18. The equipment was set up on the roof of the building, and six shower bath heads adjusted to shower tap water down on the equipment. No method was available for getting any salt water as the specifications call for. The equipment was subjected to 41 hours of water spray. Three or four minutes after the water was turned on the "Time Out" values were very erratic. However, it was decided to continue the spray test in order to determine which components would fail. At the end of 41 hours, the control box was completely filled with water, the gyro had considerable amount of water in it, and the altimeter face was about one-fourth full of water. The inside of the computer unit was quite wet but no water had collected in any appreciable amount. No water had penetrated into the sealed chamber of the computer. The water was drained from the units and the set did not operate satisfactorily. The "Time Out" values were very erratic and there was enough leakage across the pins of the gyro cable and inside the gyro to load the plus 150 volt circuit to a point where the VR 150 would not fire.

19. The resistance of the cable pins to ground was of the order of 200,000 ohms except on the cables that had been very thoroughly treated with Dow-Corning #4 Compound. The cables that had been treated very thoroughly measured about 1,000 megohms from the pins to ground. None of the plugs on the units themselves had been treated with Dow-Corning #4 and water was dripping right through the plugs. These plugs on the units also showed a very low resistance from their pins to ground.

20. The units were left in the sun for 5 hours to dry and then reconnected and the equipment operated. The computer unit and the control box had dried out enough for the equipment to work. The gyro unit and the altimeter still did not operate satisfactorily.

Visual Inspection

21. Upon completion of these tests, a visual inspection of the equipment showed that the following parts had corroded or rusted:

(a) The metal parts of the gyro shock mounts rusted.

(b) The ballast tube, shock mount rusted.

(c) End bell screws on the dynamotor rusted.

Weights

22. The weights of the units were found to be as follows:

Control Box	1.0	lbs.
Gyro Unit	7.5	"
Computer Unit	23.8	"
Altimeter with Cable	1.8	"
Transfer Switch Box with Cables	1.0	"
Indicator Lamp	0.25	"
Cables	4.8	"
Total weight	40.15	lbs

CONCLUSIONS

It is concluded that:

23. The AN/ASG-10 will operate satisfactorily over the range of minus 30° C to plus 50° C with low humidity.

24. "Time Out" values will be within 2% over the range of minus 30°C to plus 50°C.

25. "Time Out" values do not change appreciably up to 37,000 feet.

26. The collection of moisture inside the face of the altimeter gives a low enough leakage resistance from the altimeter contacts to ground to prevent the altimeter triggering the equipment and feeding "time in".

27. If the leakage resistance to ground anywhere in the altimeter or test switch leads becomes as low as 4 megohms, it is impossible to feed "time in".

28. The cables supplied with the AN/ASG-10 are unsatisfactory for Naval aircraft use. A complete new set of cables of vinylite wire was made up before the beginning of the tests and used during all of the type tests.

29. The AN/ASG-10 can be made to give "Time Out" values accurately to within 3% to 4% at plus 50°C. 97% humidity provided all wire used in the cables and in the units is changed to vinylite covered wire.

30. The error can be reduced to approximately 2%, if, as well as changing to vinylite insulated wire, R103 is placed inside the sealed chamber and R301 is treated to prevent leakage.

31. The leakage between the contacts of the "test" switch under conditions of plus 50°C and 97% humidity is sufficient to prevent time from being fed into the equipment.

32. After the equipment is subjected to humid conditions, the release relay, contacts, are corroded; hence, they intermittently make positive contact and cause faulty release operation.

33. The equipment will not work satisfactorily under conditions of the Spray Test.

34. If the equipment is dried out thoroughly after a spray test, all units should work satisfactorily except the gyro units. Twenty-four hours after completion of the spray test, the gyro unit was still inoperative.

35. If the plugs used on the units and on the cables are very thoroughly packed with Dow-Corning #4 compound, a high leakage resistance approximately 1,000 megohms, will be maintained under spray conditions.

RECOMMENDATIONS

It is recommended that:

36. All cables be made up of vinylite wire.

37. All wire used in the AN/ASG-10 equipment be changed to vinylite wire.

38. R103 be placed inside the sealed chamber, if possible.

39. R301 be treated to prevent leakage under humidity conditions.

40. The field men be notified to clean the contacts of the release relay frequently, in order to insure positive contact of the relay.

41. The test switch be treated to prevent leakage across its terminals. A leakage resistance across this switch of 4 megohms will make the equipment inoperative.

42. The plugs used on the units and on the cables be very thoroughly packed, both inside and out, with Dow-Corning #4 compound. If this is done, no trouble with the cables should be experienced under spray conditions.

REFERENCES

(a) BuAer ltr Aer-E-3144-RWD F42-5/101 (AN/ASG-10) Request for Assignment of Problem to NRL dtd 24 January 1945

(b) BuShips Specifications RE 13A825C for Type Testing Airborne Electronic Equipment.

(c) BuAer Specifications NAVAER-EP-254 Description and Performance Specifications for AN/ASG-10 Computing Set dtd 4 January 1945.

(d) BuAer Specifications Mod II of NAVAER-EP-254.

(e) Final Report on Problem A138T-C Ser. C-F42-5(311-1:LWF:MLB) C-310-28/45(lbr)